Edgewood Chemical Biological Center

FY13 Section 219 Innovative Project Program Highlights

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A MESSAGE FROM THE DIRECTOR OF ECBC RESEARCH AND TECHNOLOGY

Greetings,

As the Director of Research and Technology for the U.S. Army Edgewood Chemical Biological Center, I had the opportunity to oversee the Center's Section 219 Innovative Project Program, and I am very proud to share some of the program highlights with you all. The Section 219 Innovative Project Program is an opportunity for ECBC to invest in the ideas of its researchers and engineers. The objective of this initiative is to provide a platform for innovative ideas that are intended to push technology to meet customer needs and ideally to expedite transitions to the warfighter. This opportunity is made possible by the 47 United States Code, Section 219 funding that provides a mechanism for Department of Defense laboratories to invest in infrastructure, training or research and development.

The content of this booklet represents the Center's commitment to the warfighter, and demonstrates the breadth of skill sets and facilities available within the Center. Oftentimes, due to different requirements, our researchers and engineers do not get the opportunity to combine skills to collaborate and develop unique products. We are able to accomplish this through 219 funds.

ECBC's world-class scientists and engineers were able to showcase their expertise in nine functionally diverse proposals that were funded in FY13, five of which are highlighted here. From a backpack stand that warfighters could use to keep their personal belongings away from potentially hazardous materials, to researching what happens when protective mask filters are exposed to certain temperatures, each proposal aims to increase survivability of the warfighter.

The Section 219 Innovative Projects Program is supported by the ECBC Counter Threats Team. This team is made of scientists and engineers from various disciplines throughout the Center who strategize around maintaining and growing ECBC's Core Competencies to counter enduring and emerging threats. Counter Threats is one of the Center's three Strategic Goals, the two others are devoted to customer service and employee development.

As we present to you some highlights from FY13, and work toward our FY14 iteration, we hope that these proposals demonstrate the intellect, hard work and commitment that ECBC has to offer, and will inspire others to think of innovative ways to serve the warfighter.

For more information about ECBC, please refer to the information on the back of this booklet. For information about any specific project, please contact the designated point of contact.

V/R,

Joseph Corriveau, Ph.D
Director, Edgewood Chemical Biological Center Research & Technology

COLORIMETRIC DETECTION USING MICROFLUIDICS

Ever since the Haber-Bosch Process led to the synthesis of ammonia, homemade explosives (HMEs) have remained a threat to the warfighter overseas and domestic. ECBC recognized the need for a simple and portable device that can detect hazardous chemicals in the field. Scientists developed a concept disk that uses microfluidics, a process that sends liquids to the edges of a disc, and colorimetric chemistry to detect agents in a given sample.

Previous detection efforts have assumed bountiful spillage in the field, which requires the warfighter to use bulk powders to identify Toxic Industrial Chemicals (TICs) and HMEs in large quantities that are not as likely to find in the field. ECBC developed a method using small volume chemistries to identify targets. Microfluidic designs use micropumps to send very small scales (micro liters) of liquid through small channels to different sections of a small disk. ECBC's design eliminates the need for these parts by incorporating a centripetal design, a circular disk that spins, using centripetal acceleration to send samples to the outer rim of the disk for testing. This technology exists most notably in pool chemistry, pioneered by the Lamotte Company. The goal of this 219 project was to test for TICs and HMEs in a similar system to Lamotte.

The process for loading disks with reagent was modified to eliminate false negative results for both the urea test and the Tributylamine (TBA) test. The urea worked in every successive test. The microfluidic disk adequately shows that a color change can be achieved using loaded reagents and analytes, after spinning. The disk showed liquid traveling to all reaction chambers consistently.

After the success with four wells, ECBC fabricated a 16-well disk with intentions of running tests with the same analytes and reagents used with the six well disk. The next step for this research is to continue testing the 16-well disk fabricated in-house and to prove new chemistries using the platform that was developed with the 219 funds. ECBC is looking to build additional partnerships to further testing on this project.

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EFFECTS OF M61 FILTER FROM HIGH CONCENTRATION OF TICs

Filtration of toxic chemicals at extreme concentrations can and has led to filter fires on occasion, but little is known about the threshold concentration and conditions for ignition. Using the M61 filter from the Joint Service General Protective Mask (JSGPM) with hydrogen sulfide and sulfur dioxide challenges as a model system tested to failure, this project sought to determine the concentration and time profile for filter fires so that users can more readily assess if a filter can be safely used in a particular event. These chemicals are considered high priority toxic industrial chemicals by the Department of Defense, and pose operational hazards in certain locations. Additional information, such as the concentration of toxic combustion byproducts carbon dioxide and carbon monoxide, was obtained by monitoring the composition of the filter effluent prior to ignition.

During the period of performance, the team was able to determine a threshold where the filters could become potentially dangerous. The risk of filter fire is greater at low humidity conditions, but decreases as more moisture is present in the atmosphere. Using this knowledge, ECBC plans to inform users and distributors. In the future, ECBC is looking to work with Technical Support Working Group (TSWG) and the United States Marine Corps to create a database, develop an end-of-service life indicator, and send information to users to ensure filters are used properly. Additional chemicals may also be evaluated to develop a robust understanding of filter limitations in a variety of operational scenarios.

ECBC has written a technical report about its findings, and the Chemical Biological Radiological Filtration Branch at ECBC is working to create a non-combustible filter material called the CoZZAT. This material has been transitioned to the Joint Project Manager for Protection (JPM P), and prototypes containing the material are currently undergoing testing in support of eventual fielding.

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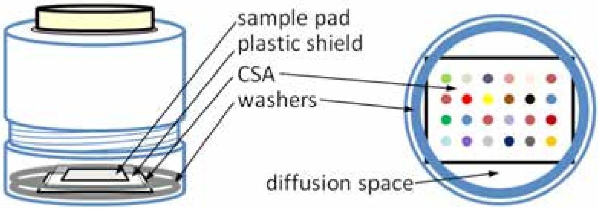

DISPOSABLE MULTIPLEX 'TEST STRIPS' FOR CWA IDENTIFICATION

Colorimetric sensor arrays (CSAs) are disposal, color-changing grids sensitive to chemical dyes. The inexpensive printed CSAs have been used to effectively detect and identify volatile chemicals , with limits of detection typically below permissible exposure limits (PEL) for toxic industrial compounds. This project assessed the ability of CSAs to detect defense-relevant chemical threats and make an initial survey of the relationship between time, chemical concentration, and the progress of the color changes exhibited by these dyes.

CSAs can specifically recognize a tremendous number of compounds and are generally robust against mixtures. The technology is licensed by iSense, LLC., and an active cooperative research and development agreement is in place with ECBC for the defense-focused development of this technology. In addition below-PEL detection of toxic industrial compounds, these sensors have been previously shown to discriminate between pathogenic and non-pathogenic strains of the same bacteria 'by smell' and to distinguish between varieties of coffee from the same manufacturer.

In this effort, ECBC accomplished several objectives:

1. Determined that CSAs displayed unique signatures when challenged with vaporous and liquid agent
2. Developed novel disposable exposure chambers to challenge CSAs with controlled-mass agent vapor streams
3. Developed efficient protocols to expose CSAs to liquid agent with minimal agent use
4. Determined that agent signatures and contaminant / confusant backgrounds were readily separable

It was found that in controlled-mass vapor exposures that CSAs were unlikely to be immediately applicable to detect-to-warn applications. This is due mostly to the high toxicities of CWAs—to provide adequate warning the agent must be detected at much lower levels than typical toxic industrial compounds.

The Defense Threat Reduction Agency will support ECBC to build a signature library and develop initial algorithms for image interpretation and signature identification. Data from this effort was essential to prove that this technology has applicability to CWA detection and identification.

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RAPID-DETECT-IDENTIFY DECONTAMINATE KIT FOR BIOLOGICAL AGENT HAZARD MITIGATION IN AIRCRAFT INTERIORS

In the aftermath of a biological attack, aircraft decontamination would be a complex, challenging process. In this project, ECBC set out to develop technologies for effective aircraft decontamination without adversely affecting the aircrafts' sensitive equipment and electronics. Current biological decontamination systems for aircraft rely mostly on thermal decontamination and vaporized hydrogen peroxide (VHP). Current tactics, techniques and procedures (TTPs) in the Air Force Manual (AFMAN) 10-2503 cite the use of a wet/damp cloth to wipe surfaces for spot-decontamination of suspected biological agents. Alternative options that are compatible with aircraft interiors are needed to ensure decontamination and operability of aircraft interiors. ECBC used a C-130 aircraft as a testbed to evaluate the decontamination efficiency of Surface Decontamination Foam (SDF) technology against barcoded *Bacillus thuringiensis kurstaki* spores used as a simulant for *B. anthracis*. The decontamination efficacy was determined by measuring the pre- and post-decontamination levels of the spores using Hand Held Assays (HHA) and polymerase chain reaction (PCR). SDF decontaminant achieved an approximate 10,000,000 fold reduction and zero residual threshold.

ECBC demonstrated proof-of-concept for the Rapid Detect-Identify-Decontaminate Kit for biological hazard mitigation in aircraft interiors. The approach can be applied to real world situations such as cases where a commercial jet liner is exposed to natural or deliberate disease pathogens. Therefore, a conceptual rendering of the kit was developed (pictured above). The kit includes government-off-the-shelf (GOTS) HHA for rapid pathogen identification, as well as decontamination and personal protection components.

This project explored an approach for rapid detection and decontamination of aircraft interiors using a kit designed for sample collection, detection and decontamination of suspected areas. The entire kit weighs approximately 10 pounds and contains all reagents and supplies for performing 20 tests. The colorimetric assay takes approximately two hours, including sample collection, decontamination and detection, and is performed by one operator.

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BACKPACK STAND FOR MISSION ORIENTED PROTECTIVE GEAR

Warfighters are tasked to collect and test samples in the field while suited in full Mission Oriented Protective Posture (MOPP) gear. The warfighters carry their equipment in backpacks and use these backpacks as a workspace while collecting samples. Warfighters typically position their backpacks/equipment on the ground near the area or item to be collected or tested. When their backpack is placed on the ground near the substance being sampled the warfighter takes the chance of unknowingly contaminating their gear. The backpack is then worn on their back and transported to other areas possibly spreading the contamination. Incorporating a stand into the backpack keeps the backpack off the ground not only provides the warfighter a safer work environment but also a comfortable workstation.

This project refined the design of the 20th Support Command prototype backpack stand previously developed by ECBC's Advanced Design and Manufacturing Division and fabricated additional prototypes for functional evaluation. The backpack stand is adaptable to a large range of backpacks that are issued by the U.S. Army and potentially applicable to backpacks donned by the other services and civilian first responders.

The stand was designed as a universal item and does not require any modifications to the backpack itself. The stand is lightweight and easy to quickly deploy. It is retracted, free standing, and able to support a standard issue fully loaded backpack. The stand will collapse down to a size similar to the height of the backpack and come in a bag that could be strapped to the backpack or stored inside the bag.

ECBC is evaluating the use of this concept in support of a current unrelated project.

ECBC is working with the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD) Joint Project Manager - Protection (JPM-P) Contamination Indicator Decontamination Assurance System (CIDAS) Product Manager to design a mid-scale CIDAS applicator. CIDAS is a Joint Service program with participation by the US Army, US Navy, US Air Force, United States Special Operations Command, and the Marine Corps. CIDAS will indicate the presence and location of traditional nerve and blister chemical warfare agents and nontraditional agents on tactical vehicles, aircraft, shipboard surfaces, crew-served weapons, and individual/personnel weapons pre- and post-decontamination.

The current applicator design is worn by the user as a backpack to improve maneuverability and avoid dragging the applicator on the ground through potentially contaminated areas. ECBC will be evaluating the use of the backpack stand to hold the mid-scale applicator off of the potentially contaminated ground when the applicator is not in use, during setup, while refilling, and repowering.

This concept can be adapted to fit a plethora of missions and is simple enough that organizations can make it fit their specific needs.

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For more information about ECBC and its projects please visit the website https://www.ecbc.army.mil or any of the social media sites below:

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